Original Research Article

The profile of Blood Pressure (BP) and the prevalence of Hypertension in school going children aged 5-15 years of Manipur, a North-Eastern hilly Indian state

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ABSTRACT

Background: Changing trend in lifestyle and increasing incidence of obesity in children may have a bearing on increasing incidence of adulthood hypertension. Recognition and timely intervention of childhood hypertension at the early stage may be the best strategy to decrease the burden of hypertension in the adult.

Methods: This is a cross sectional study where school going children aged 5-15 years of age were examined physically and by 2D color Doppler Echocardiography. Children with systemic illness or any heart disease (structural or functional), were excluded. Anthropometric measurements particularly waist circumference and body mass index (BMI) were calculated and BP was recorded by aneroid sphygmomanometer. Statistical analysis was done using IBM SPSS Statistics version 22, and descriptive statistics like percentages, mean, median, standard deviation were generated.

Results: Of the 2946 children selected out of 3600 examined, 1570 (53.30%) were boys and 1376 (46.7%) were girls with mean age of 11.06 years. The mean BMI was $17.82 \pm 3.76 \text{ kgm}^{-2}$. The prevalence of normal, underweight, overweight and obesity were 84%, 6.3%, 8.04%, and 1.7 % respectively. The average mean SBP/DBP in children aged 5-10 years was $(99.6 \pm 10.4)/(64.8 \pm 9.5) \text{ mmHg}$, while that in the group of 10-15 years was $(105.2 \pm 11.5)/(67.4 \pm 9.1) \text{ mmHg}$. The total prevalence of pre-hypertension and hypertension in the study group were 516 (17.5%) and 451 (15.3%) respectively. Hypertension was detected in 14.55% of healthy weight, 21.6% of overweight and 29.4% of obese children.

Conclusions: The prevalence of pre-hypertension and hypertension in school going children and adolescent is surprisingly quite high with a strong correlation with overweight and obese children.

Keywords: Children, Hypertension, North-eastern India

INTRODUCTION

We are well aware of the increasing prevalence of hypertension in our society and its associated complications, contributing to a major cause of morbidity, mortality of mankind and its economic impact. Of late, childhood hypertension is recognized as an

important predecessor of adult hypertension, with an estimated population prevalence of 1-2% in the developed countries, and around 5-10% in developing countries like India, which is still an underestimated problem in this part of the world.^{1,2} Increasing number of children are now diagnosed with primary hypertension, which may be due to obesity and lifestyle changes,

mainly physical inactivity and change in dietary pattern. At the same time, there has been reports of increased prevalence of overweight and obesity in childhood.³⁻⁵ In addition, since obesity and hypertension have the tendency to track from childhood into adulthood, the burden of hypertension in adults will rise. Moreover, study in North Eastern states of India also reveals a high burden of hypertension in the adult population.⁶

Recognition and timely intervention of childhood hypertension at an early stage may be the perfect tool to nip the burden of hypertension in adulthood at the bud to some extent. So, we are trying to look the prevalence of hypertension and its supposedly positive correlation with obesity in school going children in Manipur, from where there is extremely limited report till date to the best of our knowledge. Also, to our best knowledge, there has been no report of the prevalence of hypertension in individuals with structurally and functionally normal heart.

METHODS

This study was a prospective cross-sectional study conducted in randomly selected schools in different parts of almost the entire state of Manipur between 2012 and 2015. The study was conducted as a part of the study of the burden of rheumatic heart disease in both the rural and urban population of the state. The study was approved by the ethics committee of Jawaharlal Nehru Institute of Medical Sciences, Imphal.

Children between the age of 5 and 15 years were enrolled after obtaining written informed consent from their parents and the school authority, done through proper channel. Relevant history taking and clinical examinations were done by doctors of postgraduate degree or diploma holders while the anthropometric measurements were performed by trained paramedics. Children with any systemic illness and on antihypertensive medication were excluded. 2D Echo with doppler study was done at the site with portable 2D Echo machine (Sonosite M Turbo, USA) and those with detectable significant abnormality of the heart, either congenital or acquired, were further excluded from the study.

The age was recorded from the school chart. Procedures being undertaken were properly explained to them beforehand. Height and weight were measured using stadiometer with beam balance with sensitivity of 0.1 cm and 0.1 kg respectively. BMI was calculated using the Quetelet index i.e. weight in kg, height in m² and values were compared with WHO Growth charts.⁷ Children with a BMI <5th percentile of reference data were considered underweight, >85th percentile were considered overweight and those with a BMI >95th percentile were considered obese.⁸ Waist circumference was measured with a non-stretchable tape at the midpoint of the lowest rib cage and the iliac crest, to the nearest 0.1 cm, in a standing position during end-tidal expiration. Taking the

reference of Khadilkar A et al study, 70th percentile waist circumference cutoff values were used to compare with the blood pressure.⁹ Blood pressure was measured using cuff of appropriate size with aneroid sphygmomanometer in the right arm sitting position after resting them for at least 5 minutes. An average of three readings was noted. In case of higher than expected value of BP, the measurement was repeated on the left arm as well. The BP values were compared with the value given by the update of 1987 task force report of NHBEP (National High BP Education Programme) co-ordination committee and children were classified as normal, prehypertension and hypertension.¹⁰ Prehypertension was defined as SBP and/or DBP between the 90th and 95th percentile for height for age and sex or $\geq 120/80$ mmHg and hypertension as $\geq 95^{\text{th}}$ percentile for height for age and sex.

Statistical analysis

Data analysis was done using IBM SPSS Statistics version 22. Descriptive statistics like percentages, mean, median, standard deviation were generated. Analytical statistics like chi-square test was performed to see for association. A p-value of <0.05 was taken as significant.

RESULTS

The total number of children finally selected for the study was 2946.

Table 1: Baseline characteristics of 2946 children.

Variable	Categories	Number (%)
Age (year)	<10	820 (27.8)
	≥ 10	2126 (72.2)
Gender	Male	1570 (53.3)
	Female	1376 (46.7)
District/residence	Bishnupur	97 (3.3)
	Chandel	131 (4.4)
	Churachandpur	227 (7.7)
	Imphal-east	892 (30.3)
	Imphal-west	747 (25.4)
	Senapati	403 (13.7)
	Tamenglong	180 (6.1)
	Thoubal	157 (5.3)
	Ukhrul	112 (3.8)
Type of house	Kutcha	2289 (77.7)
	Pucca	657 (22.3)
Type of school	Government	1183 (40.2)
	Private	1763 (59.8)
Average family annual income (rupees)	<10,000/-	2448 (83.1)
	10,000/- to <25,000/-	331 (11.2)
	25,000/- to <50,000/-	125 (4.2)
	50,000/- and above	42 (1.4)

Out of these, 1570 (53.3%) were boys and 1376 (46.7%) were girls, with mean age of 11.06 years (5-15 years). Majority of the children belong to older age group of more than 10 years (72.2 % versus 27.8%). The representation from the private school was relatively higher (59.8% versus 40.2%). Poor socioeconomic status of the children was reflected by the number of children with average annual family income of less than Rs. 10000 found to be 83 %, while the number of kutcha house dweller was 77.7% in the entire study population. The characteristics of the study population are given in the Table 1.

Majority of the study population were in the healthy weight or normal BMI category (84%). The mean BMI was 17.82 ± 3.76 kg/m². The prevalence of underweight, overweight and obesity group in the study population were 6.3%, 8.0% and 1.7% respectively. The average mean SBP/DBP in children aged 5-10 years was $(99.6 \pm 10.4)/(64.8 \pm 9.5)$ mmHg, while in the group of 10-15 years was $(105.2 \pm 11.5)/(67.4 \pm 9.1)$ mmHg. Hypertension was detected in 14.5% of healthy weight,

21.6% of overweight, 29.4% of obese children, showing increasing trend of hypertension with increasing BMI (Table 4). To be noteworthy is the 14.6% prevalence of hypertension in the underweight group, indicating underweight may also be one of the important determinants of hypertension just like overweight and obesity. The age wise mean SBP, DBP and BMI percentile were given in Table 2. In the present study, we observed high prevalence of prehypertension as well as hypertension in overweight and obese children which was found to be statistically significant.

The mean waist circumference of boys between 5-10 years group and 11-15 years group were 53.9 ± 5.5 cm and 63.6 ± 6.8 cm; of girls were 53.6 ± 5.6 cm and 63.8 ± 7.5 cm respectively. In the age group 11-15 years, children with waist circumference above 70th percentile cutoff value were found to be more hypertensive than the children below it, which was found to be statistically significant. However, even though similar pattern was seen in the age group 5-10 years, it was not statistically significant.

Table 2: Distribution of mean BP and BMI percentile in different age groups.

Age (year)	Number		SBP (mmHg) (Mean±SD)		DBP (mmHg) (Mean±SD)		BMI percentile (Mean±SD)	
	Male	Female	Male	Female	Male	Female	Male	Female
5	40	48	93.2 (9.4)	94.1 (9.9)	58.2 (7.8)	59.3 (8.3)	59.2 (33.5)	57.3 (29.0)
6	71	64	97.4 (10.2)	102.1 (11.6)	63.7 (9.9)	65.3 (9.9)	44.7 (28.7)	45.5 (31.2)
7	95	97	100.1 (10.5)	99.6 (10.8)	64.2 (10.6)	65.6 (9.4)	49.7 (29.2)	46.3 (24.7)
8	80	108	98.5 (9.3)	101.4 (8.9)	64.0 (8.2)	67.2 (9.0)	47.2 (28.6)	45.9 (26.9)
9	104	113	101.4 (9.8)	100.9 (10.6)	66.4 (8.6)	66.5 (9.2)	47.5 (25.3)	47.2 (23.0)
10	160	170	101.5 (9.7)	101.3 (10.1)	66.0 (9.4)	66.6 (9.3)	44.7 (27.8)	44.6 (25.0)
11	153	104	102.2 (9.4)	105.8 (11.6)	67.0 (8.7)	66.0 (9.3)	36.6 (23.4)	43.0 (28.6)
12	200	171	103.6 (11.3)	105.4 (11.3)	66.6 (9.5)	66.7 (9.5)	39.9 (26.2)	42.3 (28.6)
13	254	172	103.6 (11.4)	106.0 (11.9)	66.3 (8.6)	67.8 (9.1)	44.8 (27.8)	51.0 (28.3)
14	205	172	105.4 (10.7)	109.3 (12.5)	67.9 (8.2)	70.2 (8.6)	49.5 (26.4)	58.2 (25.1)
15	208	157	109.1 (12.5)	107.8 (11.3)	68.7 (8.5)	70.0 (9.5)	57.3 (24.5)	59.6 (24.0)
Total	1570	1376	103.1 (11.2)	104.2 (11.6)	66.4 (9.1)	67.1 (9.4)	46.6 (27.4)	49.3 (27.1)

The total prevalence of prehypertension and hypertension in the study group were 516 (17.5%) and 451 (15.3%) respectively. Gender wise, the prevalence of prehypertension and hypertension in boys were 304 (19.4%) and 177 (11.3%), and in girls 212 (15.4%) and 274 (19.9%) respectively, showing higher prevalence of hypertension in girls. Mean SBP (SD) was 103.58 (11.49) mmHg with mean percentile (SD) of 54.20 (29.0) and mean DBP (SD) 66.72 (9.27) mmHg with mean percentile (SD) of 67.3 (24.2), with systolic prehypertensive and hypertensive of 4.8% and 9.2%, and diastolic prehypertensive and hypertensive of 16.2% and 8.5% respectively. Prevalence of hypertension in the age group <10 years, which comprised 27.8% of the studied population (820 nos.) showed prevalence of prehypertension and hypertension as 11.3 % and 27.6% respectively and age group >10 years (1554 nos.) as pre-

hypertension of 19.9% and hypertension of 10.6%, with younger age group although comprising fewer population, being more hypertensive (Table 3).

Considering the type of school and area wise, the prevalence of prehypertension and hypertension in children studying in private school and in urban area were significantly higher than students studying in Government school and in rural area ($p=0.001$). Residential houses were classified into 2 groups of pucca and kutcha, where prevalence of prehypertension and hypertension in kutcha dwellers were higher than that of pucca dwellers, although not statistically significant. As a simplified marker of socioeconomic condition of the study population, average monthly family income was divided into 4 groups and the distribution of BP was studied. Family with average monthly income of Rs

50,000/- and above, the most affluent group in the study Population had more hypertensive children (23.8%) than the other groups, but not statistically significant Table 4.

Table 3: Distribution of prehypertension, hypertension and BMI.

Variable	Categories	Number (%)
SBP	Normal	2534 (86.0)
	Prehypertension	140 (4.8)
	Hypertension	272 (9.2)
DBP	Normal	2221 (75.4)
	Prehypertension	476 (16.2)
	Hypertension	249 (8.5)
Hypertension prevalence	Normal	1979 (67.2)
	Prehypertension	516 (17.5)
	Hypertension	451 (15.3)
BMI percentile	Underweight	185 (6.3)
	Normal weight	2474 (84.0)
	Overweight	236 (8.0)
	Obese	51 (1.7)

DISCUSSION

This present study was done in selected school going children of all different districts of Manipur with sample population proportionate to population density of the said districts as shown in Table 1. So, the study data can be regarded as true representative of different population residing in Manipur and thereby the blood pressure profile of school going children of Manipur. Present study showed high prevalence of prehypertension and hypertension at the figure of 17.5% and 15.3% respectively, which may be corroborative with a small study previously done in Imphal in 2006 by Sanayaima H et al with the prevalence of 15.7%, although it was done in higher secondary school students.¹¹ Girls were found to be more hypertensive than boys, as also found in the study of Borah PK in Assam, a neighboring state of Manipur.¹² It was also clearly seen that with increasing BMI, the prevalence of hypertension also increased hand in hand reaffirming the positive correlation of overweight and obesity with hypertension but importantly also in underweight children, indicating that malnutrition can still lead to hypertension.

Table 4: Comparison of different variables with BP.

Variables		Blood pressure			p- value
		Normal (%)	Prehypertension (%)	Hypertension (%)	
Gender	Male	1089 (69.4)	304 (19.4)	177 (11.3)	0.001
	Female	890 (64.7)	212 (15.4)	274 (19.9)	
School type	Government	847 (71.6)	163 (13.8)	173 (14.6)	0.001
	Private	1132 (64.2)	353 (20.0)	278 (15.8)	
Age group	<10 years	501 (61.1)	93 (11.3)	226 (27.6)	0.001
	≥10 years	1478 (69.5)	423 (19.9)	225 (10.6)	
BMI	Underweight	131 (70.8)	27 (14.6)	27 (14.6)	0.005
	Normal weight	1671 (67.5)	445 (18.0)	358 (14.5)	
	Overweight	150 (63.6)	35 (14.8)	51 (21.6)	
	Obese	27 (52.9)	9 (17.6)	15 (29.4)	
House type	Kutchia	1547 (67.6)	383 (16.7)	359 (15.7)	0.09
	Pukka	432 (65.8)	133 (20.2)	92 (14.0)	
Average annual family income (rupees)	<10,000/-	1661 (67.9)	416 (17.0)	371 (15.2)	0.248
	10,000-<25,000/-	215 (65.0)	68 (20.5)	48 (14.5)	
	25,000-<50,000/-	76 (60.8)	27 (21.6)	22 (17.6)	
	50,000 and above	27 (64.3)	5 (11.9)	10 (23.8)	
Place	Rural	667 (63.3)	256 (24.3)	130 (12.3)	0.001
	Urban	1312 (69.3)	260 (13.7)	321 (17.0)	
Waist (5-10 years) circumference	<70 th percentile	466 (63.1)	137 (18.6)	135 (18.3)	0.55
	≥70 th percentile	15 (55.6)	7 (25.9)	5 (18.5)	
Waist (10-15 years) circumference	<70 th percentile	579 (68.9)	191 (22.7)	70 (8.3)	0.001
	≥70 th percentile	570 (73.6)	98 (12.7)	106 (13.7)	

Mentioning a few studies done earlier in different regions of India as shown in Table 5, prevalence of hypertension in the school going children hovers in the range of 3-

10%. A systematic review and meta-regression on prevalence of high blood pressure in 122,053 adolescents in 2014 by de Moraes et al showed that the pooled-

prevalence of high BP was 13% for boys, and 9.6% for girls ($P < 0.01$).¹³ Works done by Durrani AM et al showed hypertension in 15 years old boys and girls group to be 19.51% and 16.66% respectively with overall prevalence of 9.36% (boys) and 9.46% (girls) in their study population.¹⁴ Kavitha B et al showed overall prevalence of hypertension and pre-hypertension as 10.9% and 8.2% respectively (boys 39% and girls 61%) with 22% in 14 years old girls group.¹⁵ These two studies indicated higher prevalence than average in the 14 to 15 years age group in the adolescent. Sundar JS et al showed overall prevalence of 21.5%, although the study

population was small.¹⁶ Although relatively higher hypertensive figure was shown in these aforementioned studies, an important probable factor for higher figure than national average in the present study could be due to measurement of BP in a single visit as also demonstrated in studies like Muscatine study where persistent hypertension dropped from initial screening value of 13% to less than 1%.¹⁷ Similarly Patel U et al also showed the decrement of BP on different visits.¹⁸ So measurement on minimum of three separate visits seems to be the ideal method before labeling as persistent hypertension.

Table 5: Comparison of prevalence of hypertension (HTN) in different regions of India.

City/state	Year	Age (years)	No.	Prevalence of HTN (%)
Ludhiana, Mohan et al ²³	2004	11-17	2467	9.25
Delhi, Kaur S et al ²⁴	2005-6	5-16	10,248	3.8-4.4
Aligarh, Durrani AM et al ¹²	2006-7	12-16	701	9.4
Wardha, Taksande A et al ²⁵	2008	6-17	2643	5.75
Kolkata, Saha L et al ²⁶	2008	10-19	1081	2.9
Shimla, Sharma A et al ²⁷	2010	11-17	1085	5.9
Surat, Buch N et al ²²	2011	6-18	1249	6.48
Northeast, Prasanta KR et al ¹²	2013	5-14	10,003	7.6
Bhopal, Patel U et al ¹⁸	2013	11-18	1006	5.36
Karnataka, Baradol RV et al ²⁸	2014	10-16	2800	21 (overweight) and 25 (obese)
Odissa, Satyajit et al ²⁹	2014	10-16	5155	3.68
Aurangabad, Saaduddin M et al ³⁰	2014	6-16	255	13.34
Tamil Nadu, Kishorkumar D et al ³¹	2016	11-15	310	10
Puducherry, Kavitha B et al ¹⁵	2016 (publication)	12-17	1005	10.9
Kerala, Naha NK et al ³²	-	5-10	1610	4.5

The prevalence of overweight and obesity were 8.0% and 1.7% with mean BMI of 17.82 ± 3.76 kg/m² which showed a little increasing trend from the earlier study done in Manipur in 2005-6 by Bishwalata R et al (the prevalence of overweight was 4.2% and obesity 0.8% in that study population).¹⁹ Another limelight of this study is the increasing trend of BP with the increased in BMI, with hypertension in 21.6% of overweight and 29.4% of obese children as compared to 14.5% in children with normal BMI, the correlation being statistically significant. This correlation and important role of overweight and obesity in the causation of hypertension has been shown by many studies done earlier in India.^{15,20,21}

The prevalence of hypertension was also more in children studying in private school as compared to Government school, and in urban than rural area which was statistically significant, as also shown in Buch N et al study in Surat and Mohan and co-workers study in Ludhiana respectively.^{22,23} Although not statistically significant in the present study, prevalence of hypertension was more in the well to do family with family income of >Rs 50,000 per month. These correlations of hypertension with private schools, urban

area and higher figure with better family income may be explained by the higher prevalence of overweight and obese children in these mentioned areas. The increased in the proportion of overweight and obese children in our society can be the major contributor of the increased prevalence of prehypertension and hypertension with the simple reason being the overwhelming changes in lifestyle of boys and girls of present generation. The sedentary lifestyle, overdependence on electronic gadgets, stress and ever-increasing competitiveness in every field can be the reason for this changing scenario which in turn implies the importance of health education in school.

The main limitation of this study is the measurement of BP in a single visit, which may be one of the important factors for higher prevalence of hypertension in the present study. Secondly, the recording of BP in children in the school environment may be a big factor for inducing transiently high value more so in the younger children of less than 10 years. Had the examination done at home or at least in the presence of the parents, it would have alleviated the factor of stress related high blood pressure. Third, the family history of hypertension was

not assessed. Fourth, the family income of the study population, as recorded from the parent or the school record in case parents were not available, was vaguely estimated and classified, and so it may not be a true representative of the socioeconomic status of the children. Finally, larger population of study with equal distribution of different age groups would have negated the discrepancies in the prevalence of hypertension and made the findings more powerful.

CONCLUSION

This study highlights the importance of routinely measuring BP in children especially in overweight, obese children and adolescent; and the need to think over the notion of believing hypertension and its complication as the disease only of the adult and elderly. It again emphasizes the importance of health education in school, and to seriously look into the growing menace of overweight and obesity in our society. This result may be only the tip of the iceberg and presses the need to explore further in different sections of our society to really measure the burden of hypertension in the school going children so that primordial and primary preventive measures can be taken up at the grass root level, where adolescents could benefit from preventive lifestyle interventions.

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